

**Conclusion:** The total CTV-PTV margin requirement for five point ray cast and BrainLAB immobilization is less than 5mm in all three directions. In patients requiring only upper neck irradiation BrainLAB system is recommended. Overall Five point ray cast and BrainLAB immobilization was comparable in terms of setup errors, margins and comfort levels.

#### EP-1786

**Rectal distension impact on prostate CBCT-based positioning assessed with 6 degrees of freedom couch**  
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**Purpose or Objective:** The prostate requires a daily correction of its position in relation with rectal distension. With 6 degrees of freedom (DOF) couch, it is possible to correct the pitch and the roll. In this study, we sought to determine whether rectal distension might have an impact on any of these prostate translations and/or rotations during a protracted course of external beam radiation therapy for a localized prostate cancer

**Material and Methods:** The data from 15 patients with localized prostate cancer patients treated with 6 DOF couch in a single institution. Before each fraction, a CBCT was performed. The automatic fusion algorithm was set to fuse on soft tissue and it allowed correction for translations in three dimensions and rotation in the transverse plane ("roll") and axial plane ("pitch"). The rectum was contoured on each CBCT by one radiation oncologist. We determine the Cross Sectional Area (CSA) and relative CSA (CSArel) by dividing with the CSA of planning CT. The median was used to classify the patients in two groups: patients with a stable CSA and patients with an unstable CSA. The CSArel was compared between these two groups with a linear mixed model with group as fixed effect and patient as random effect

**Results:** Two hundred and ninety seven kV-CBCT were analyzed. Seven patients had a small and stable rectum : CSArel (1.07±0.09). The other eight patients had a unstable rectum: CSArel (1.37±0.07). The average pitch in the group with a stable rectum was 0.73° (+/-0.32) versus 0.04° (+/-0.28) (p=0.112). The pitch was not correlated with the CSA rel (p=0.477, r=0.041). The average roll in the group with a stable rectum was 0.14° (+/-0.27) versus 0.03° (+/-0.25) (p=0.781). The roll was not correlated with the CSA (p=0.279, r=0.063). The average CSArel was higher and more variable in the unstable group (p=0.009) and (p=0.024) respectively

**Conclusion:** Rectal distension had neither impact on the pitch nor on the roll, which suggest that a 6 DOF couch have little interest in daily practice for prostate IGRT

#### EP-1787

**View of interest of automatic registration for CBCT localisation of head and neck cancer**

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**Purpose or Objective:** Use of IMRT in patients with head and neck carcinoma may lead to over- or underdosage of OAR and CTV due to changes in patients anatomy. CBCT is a valuable tool for patient setup verification and monitoring of dosimetric variation during radiotherapy. We evaluated the dependence of an automatic registration process on the size of a user defined view of interest (VOI). We compared these results with the manual registration defined by a physician, defined as gold standard.

**Material and Methods:** We retrospectively reviewed the records of 36 consecutive patients (107 fractions) with head and neck cancer who received radiation therapy between January 2015 and September 2015 at the Hospital of Turnhout. Three CBCT images at well-defined time points (start-, mid- and end-treatment) of each patient were matched to a reference CT image using the Siemens Syngo RT Therapist version R 4.3. Images were acquired with MVision™ (6 MV photon beam tuned for imaging). Auto global registration is the automatic alignment of planning and treatment images using voxel based registration. Manual VOI function allows restricting the voxel based automatic registration to a user defined region. Registrations were performed with 2 VOI sizes (large (VOI = whole CBCT) and small (VOI = delineated CTV + body of adjacent vertebra)). Automatic registrations (AR) were compared with a manual registration (MR) made by a physician. It was only possible to make translational corrections in the vertical, longitudinal and lateral direction. To quantify overall distance between gold standard and automatic registration, the 3D-difference (d) was calculated:

$$d = \sqrt{((AR - MR)^2_{\text{lateral}} + (AR - MR)^2_{\text{longitudinal}} + (AR - MR)^2_{\text{vertical}})}$$

**Results:** The CBCT images of 107 fractions were analysed. Automatic registration results depend on the volume of VOI (large or small). A paired t-test calculated the mean 3D difference for the automatic registrations with small VOI was significantly smaller (p < 0.001) than the mean value for automatic registrations using the large VOI. 3D differences were divided in multiple ranges. Small VOI resulted in differences ≤ 2 mm between automatic registration and radiation oncologist registration in 56,1% of the cases. When using large VOI, it resulted in differences ≤ 2 mm in 6.5% of the cases. Compared with radiation oncologist registration, small VOI resulted in differences > 6 mm in 5.6% of the cases. Large VOI resulted in differences > 6 mm in 24.3% of the cases.

Table 1: Summary showing 3D differences (mm) between automatic registration (large VOI and small VOI) and manual registration by a radiation oncologist

	Large VOI	Small VOI
Mean (standard deviation)	4.88 mm (2.14)	2.36 mm (1.93)
Median	4.58 mm	2.00 mm
Maximum	10.36 mm	11.36 mm
d = 0-2 mm	6.54 %	56.07 %
d = 2-4 mm	31.78 %	30.84 %
d = 4-6 mm	37.38 %	7.48 %
d > 6 mm	24.30 %	5.61 %

**Conclusion:** Automatic registrations can produce results which are comparable to manual registrations by radiation oncologist. Registration parameters for CBCT affect differences between automatic and manual registration although patients wear a plastic mask during radiation therapy. Using a small VOI (delineated CTV + body of adjacent vertebra) results in small differences between automatic and manual registration. If large VOI is used it can result in differences > 6 mm in more than 20% of the cases.

#### EP-1788

**Accurate and stable immobilisation with Lorca Marin masks for head and neck IMRT verified by IGRT**

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**Purpose or Objective:** IMRT needs accurate and repeatedly image controls to verify online the patient position and check that the tumor is properly included. The aim of this work is to analyze the setup accuracy and stability resulting from the use of the Lorca Marin thermoplastic masks during the complete course in head and neck cancer treatment with intensity modulated techniques.

**Material and Methods:** 50 consecutive head and neck cancer treatments with IMRT were analyzed. Lorca Marin customized masks named *Nature* were used to immobilize head and neck. These 2-oxepanone polymer thermoplastic masks are 3-points immobilization with frontal and mental reinforcement and 3.2 mm thickness. 3-standard references were marked on the surface of the mask and on the middle chest of the patient for accurate positioning every day. Cone-beam computed tomography scan to verify online the position was performed during 5 consecutive days and after, weekly cone-beam (CBCT) until the end of the treatment. After weekly matching process using automated soft-tissue registration, translational movements along the three axes (x, y, z) were collected and the average for each treatment and each axis was calculated. Displacement's mean of the 50 averages and the standard deviations were analyzed and compared.

**Results:** The resulting displacement average after analyzing 50 treatments was less than 1 mm along the three axes: x =  $(0.62 \pm 0.51)$  mm, y =  $(0.83 \pm 0.63)$  mm, z =  $(0.65 \pm 0.59)$  mm. These setup displacements have remained under 3 mm in 100% of treatments. These results achieve the International Commission on Radiation Units and Measurements recommendations regarding the setup margin to compensate the immobilization and positioning errors.

**Conclusion:** The type of patient immobilization devices and their contribution in the setup errors must be taken into account for IMRT. Additionally, the use of different image-guidance systems can significantly alter the size of the required margins. Lorca Marin thermoplastics masks with weekly CBCT show enough accuracy and stability for IMRT head and neck cancer patients.

#### EP-1789

**Immobilization and dosimetric performance of a MRI compatible frame for head and neck patients**

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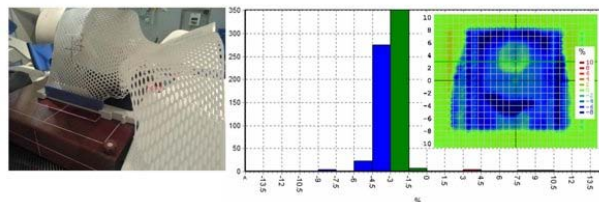
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**Purpose or Objective:** Use of CT/RMI image registration for Head&Neck cancers is challenging because of the difficult to maintain the same position in simulation CT and in MRI system. A number of immobilization devices used in radiotherapy are not appropriate for use in MRI because of compatibility problems with the materials or with the acquisition coils. A novel head and neck board, fully compatible with Head and neck MRI coils (ExaFrame, Anatge(R)), has been presented and in this work we analyse setup accuracy of both conventional and MRI compatible board.

**Material and Methods:** Attenuation measurements were done using a diode array (MapCheck2, SunNuclear) inside water equivalent phantom and 6MV photons (TPR20,10=0.685, Elekta Synergy) for orthogonal beams. Attenuation is evaluated in the area of mask fixation and in body area of frame. Five consecutive patients with head and neck tumors were assigned to simulation with MRI compatible frame using head and shoulder mask with four fixation points. Immobilization and reproducibility is improved using a customized silicone mold between patient's nose bridge and mask. Reproducibility Every treatment day CBCT images were acquired for treatment isocenter, and shifts in patient position were automatically measured using simulation CT as reference (xvi, Elekta). Displacements in antero-posterior (Vert), cranio-caudal (Long) and medio-lateral (Lat) directions, and rotations about major axis were calculated and compared with conventional carbon fiber immobilization. A total of 150 CBCT images were acquired for CompMRI frame. A group of 30 patients with conventional board was used as control (900 CBCT images). Distribution of displacements, rotation and 3D displacements were compared between both groups.

**Results:** Attenuation measurement is shown in the image, and is lower than 4% for orthogonal incidence. No artifacts on MRI image were observed. Reproducibility between MRI and CT simulation was better than 1 mm in all cases studied, based in direct versus automatic registration. The mean and standard deviation of shifts for the CompMRI board versus conventional board are shown in table 1. An analysis of variance differences using a Fisher test gives statistically significant differences between variances of two groups ( $p < 0.01$ ). The distributions of the absolute displacements were similar in both groups.



	Lat (mm)	Vert (mm)	Long (mm)	Roll (°)	Tilt (°)	Pitch (°)
C-MRI	$0.8 \pm 0.6$	$-0.3 \pm 0.9$	$-1.5 \pm 1.2$	$-0.7 \pm 0.7$	$-0.1 \pm 0.5$	$-0.1 \pm 0.3$
Conventional	$0.8 \pm 2.7$	$-1.7 \pm 3.9$	$-1.0 \pm 3.2$	$-0.4 \pm 1.2$	$0.1 \pm 1.2$	$-0.2 \pm 1.0$

**Conclusion:** Our data show that the C-MRI board have low attenuation and a better immobilization and reproducibility than the conventional board. Position reproducibility from MRI simulation and CT simulation was excellent. Combination of MRI compatible board with silicone fixation provided robust immobilization and can be safely used for MRI-CT registration procedures eliminating the use of deformable and complex software algorithms. These data could be used for a potential reduction of margins for the PTV.

#### EP-1790

**Assessment of Uterine Fundus Coverage with IGRT using daily CBCT in cervical cancer**

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**Purpose or Objective:** Inclusion of uterine fundus in the pelvic CTV for definitive treatment of cervical cancer is controversial. We aimed to demonstrate the fundus coverage by using daily CBCT with a rigorous bladder filling protocol.

**Material and Methods:** Five patients with cervical cancer without uterine fundus involvement were scanned by 2.5 mm slice thickness CT after a 30 minute, 500 cc water consumption. PET/CT and MR fusion was performed to delineate GTV and used as surrogates to see the potential motion of uterus at different imaging modalities due to bladder and rectal fillings. CTV1 was contoured to include GTV+cervix+uterus modified to be covered in simulation CT, PET/CT and MR. PTV margin of 15 mm was added according to guidelines. VMAT IMRT plans were performed to give 45 Gy in 25 fractions. Image guidance with daily kV CBCT was performed on TrueBeam STx and Trilogy linacs (Varian, Palo Alto) throughout the external phase of the treatment, which was followed by HDR brachytherapy. When the CTV1 was missed on CBCT, the bladder filling was modified accordingly; CBCT was repeated and treated after ensuring the coverage.

**Results:** Uterine fundus was contoured on a total of 125 CBCT images of 5 patients. Overall on 24 of 125 fractions (19.2%) CTV1 was out of PTV. Mean volume of CTV1 out of PTV was 0.92 cc (range 0.02-2.78 cc). Mean Dmin for fundus was 133 cGy when the CTV1 was out of PTV, while it was 176 cGy when CTV1 was covered on CBCT.

**Conclusion:** Although the inclusion of the uterine fundus in the CTV for the definitive treatment of cervical cancer without fundus involvement is controversial, potential microscopic spread is a concern. Rigorous bladder filling is a way to minimize the interfraction motion of the uterus,